FIRST KARYOTYPIC DATA ON A CUPEDID BEETLE (COLEOPTERA: ARCHOSTEMATA) SHOWING ACHIASMATIC MEIOSIS[1]

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ABSTRACT: The chromosomes of a species of Cupedidae, *Distocupes varians* (Lea) were studied for the first time. The male diploid chromosome number of the species is 2n = 19 and the male sex chromosome system is of the XO type. The presence of 9 pairs of autosomes agrees with the hypothesis that suggests that this number is the ancestral condition for the whole Order Coleoptera. On the other hand the analysis of the spermatogenesis reveals an achiasmatic meiosis pattern. The occurrence of this kind of meiosis in Cupedidae (never recorded in Polyphaga, but present in some groups of Adephaga) is in agreement with hypotheses that relate Archostemata with Adephaga.

The suborder Archostemata is a primitive group of beetles which includes three families, Cupedidae, Micromalthidae and Ommatidae (Lawrence *et al.* 1987). The only species of Micromalthidae so far karyotypically studied is *Micromalthus debilis* LeConte (Scott, 1936, 1941) which has haplodiploidy, males with n = 10 and females with 2n = 20. The family Cupedidae has 25 species worldwide and is represented in Australia by the monotypic genus *Distocupes* and four species of *Adinolepis* (Neboiss, 1984). To date nothing has been published on the karyotypes of these species.

The relationships between Archostemata and the other three suborders of Coleoptera are still in dispute. Crowson (1955, 1960) considers that there are three ancestral stocks: Archostemata, Adephaga and Myxophaga plus Polyphaga. Lawrence and Newton (1982) and Kukalová-Peck and Lawrence (in press) suggest that Archostemata, Myxophaga and Adephaga may form a monophyletic group based on wing venation and folding.

In the present paper information on the chromosomes of the species *Distocupes varians* (Lea) is reported and the relationships of its karyotype with those of the other suborders is discussed.

MATERIALS AND METHODS

Five individuals of *Distocupes varians* were collected in December

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1990 from a permanent colony living in a garden in O'Connor, Canberra, Australia. The beetles are deposited in the Australian National Insect Collection, Canberra. Male specimens wre injected with a 0.04 M sodium acetate plus 0.05% colchicine solution for ten minutes and then anesthetized. The testes were dissected out, fixed in 3:1 ethanol: acetic acid solution, and then squashed in a drop of 1% lacto-propionic orcein.

RESULTS

The male diploid chromosome number of *Distocupes varians* is 2n = 19 with nine pairs of autosomes plus X. The karyogram made from metaphase II cells (Fig. 1) shows 9 pairs of metacentric and submetacentric chromosomes gradually decreasing in size. The X chromosome seems to be a metacentric element about the size of the second pair.

In meiosis during early prophase I the homologues condense (Fig. 2, 3) and at zygotene the central regions of the bivalents, probably of heterochromatic nature, are heavily stained while the rest is weakly stained (Fig. 3). During pachytene (Fig. 4) to metaphase I (Fig. 5) the homologues remain in parallel alignment without showing any trace of chiasmata. Homologous centromeres appear more deeply separated in some bivalents (Fig. 5). The onset of anaphase I is denoted by a parallel separation of homologues, which is delayed in the telomeric regions of some bivalents (Fig. 6). At prophase II chromosomes appear as single structures (Fig. 7). The two chromatids are seen again at metaphase II, but they remain parallel instead of the typical cruciform figure due to chromatid repulsion (Fig. 8). The X chromosome condenses precociously (Fig. 4) and moves undivided to one pole at anaphase I, and divides its chromatids during anaphase II.

During specimens preparation, the testes of this species were found to be of the normal follicular type, in which a number of small sperm tubes are attached individually to the vas deferens (Snodgrass, 1935), rather than the tubular type (Jeannel, 1941), which consists of a single, coiled tube. This feature is of phylogenetic importance (see below).

DISCUSSION

Male meiosis of *Distocupes varians* resembles the achiasmatic pattern that was previously described in Adephaga (Carabidae:Bembidiini, Pogonini and perhaps Harpalini) by Serrano (1981a). Since achiasmatic meiosis is considered to have evolved secondarily (John, 1990), this character represents a specialized condition within the Cupedidae, an

unexpected result in view of the supposed archaic nature of the group. However, it may also be considered as a latent tendency of the first coleopterans that may appear in particular groups or species. Given the lack of reports of achiasmatic meiosis in the suborder Polyphaga, in spite of the large number of species studied (2000 in Smith and Virkki, 1978, and many more since then), the occurrence of this kind of meiosis is in agreement with the hypotheses that relate the suborder Archostemata with the suborder Adephaga (Lawrence and Newton, 1982; Kukalová-Peck and Lawrence, in press).

Chromosomes of *Distocupes varians*. Figure 1. Karyogram made from two metaphase II cells with n = 9 + X (above) and n = 9 (below). Figure 2. Early zygotene. Figure 3. Zygotene. Figure 4. Postpachytene stage. Note the precocious condensation of the X chromosome. Figure 5. Metaphase I. Figure 6. Anaphase I. Figure 7. Prophase II with n = 9 (left) and n = 9 + X (right). Figure 8 Metaphase II. Arrows show the X chromosome. The bar equals 5 μm.

On the other hand, the chromosome number of *Distocupes varians* 2n = 19, is very close to that found in other primitive coleopteran groups (Table 1), thus supporting the hypothesis that the 2n = 20 karyotype is ancestral for the Order Coleoptera, and that higher numbers developed thereafter in the adephagan and polyphagan stocks, with disappearance of the ancestral karyotype in modern Adephaga.

If the lack of the typical polyphagan Xyp sex-chromosome mechanism in *D. varians* is corroborated in other species of Archostemata, it will indicate that this system is characteristic of the suborder Polyphaga but is not found in the other suborders of Coleoptera (Table 1). Thus the Xyp system evolved when Polyphaga became separated from the other suborders and represents an apomorphy for the suborder.

Finally, the occurrence of follicular testes in *D. varians,* as well as in two other Cupedidae, *Priacma serrata* LeConte and *Prolixocupes lobiceps*

Table 1. Chromosome numbers in Coleoptera

Suborder	Species	References(*)
ARCHOSTEMATA		
CUPEDIDAE	*Distocupes varians* n (♂) = 9 + X 2n (♂) = 19 Male achiasmatic meiosis	1
MICROMALTHIDAE	*Micromalthus debilis* n (♂) = 10 2n (♀) = 20 Sex-chromosome mechanism by haplo-diploidy (arrhenotoky)	2
MYXOPHAGA	*Ytu zeus* n (♂) = 9 + XY 2n (♂) = 20	3
ADEPHAGA	Ancestral karyotype n (♂) = 18 + X 2n (♂) = 37	4
POLYPHAGA	Ancestral karyotype n (♂) = 9 + Xyp (parachute) 2n (♂) = 20	5

(*) 1, Present study; 2, Scott (1936); 3, Mesa and Fontanetti (1985); 4, Serrano (1981b); 5, Smith and Virkki (1978).

(LeConte) (K.W. Cooper, pers. comm.) conflicts with the reports of tubular testes in *Prolixocupes latreillei* (Solier) and also in *Tetraphalerus wagneri* Waterhouse (family Ommatidae) (Vidal-Sarmiento, 1969). It appears that tubular and follicular testes, which characterize Adephaga and Polyphaga, respectively, both occur within the suborder Archostemata. If this is the case, it suggests that modern Archostemata are not monophyletic or that this character has undergone reversal. However, more data is needed to confirm the presence of tubular testes in either Ommatidae or Cupedidae.

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